IPCM4

PCM OSCILLATOR FOR MODULAR SYNTHESIZERS

+

POLYPHONIC PCM SYNTHESIZER

USER'S MANUAL

DOCUMENT REVISION 1.1

Contents

1 - WHAT IS iPCM4?

iPCM4 is the first iOS application specifically created to use the iPad within modular synthesizer environment. It features a powerful oscillator engine designed to produce complex waveforms that are impossible to produce with any other oscillator module.

iPCM4 can also be used as a polyphonic synthesizer. In this mode, the application can be used as a standalone synthesizer but it can also be used as paraphonic oscillator, bringing huge new sound capabilities to any modular synthesizer setup.

A iPCM4 voice is made of up to four independent oscillators, each of them offering 204 different waveforms, making the application able to provide any kind of sound, from fat and deep bass sounds, to highly complex time varying spectrum sounds.

Each voice can be modulated by an envelope generator (one per channel), a pitch-control low frequency oscillator and a amplitude control low frequency oscillator.

The application can be controlled by any iOS compliant MIDI interface. It also supports RTP-MIDI, while it includes a simple keyboard for users who want to work on their sound design while being totally mobile.

Last but not least, all presets created in iPCM4 can be shared with other iPCM4 users using iTunes file exchange.

2 - A FEW WORDS ABOUT RTP-MIDI

RTP-MIDI is a worldwide open and completely free standard, listed in RFC documents (RFC6295). This guarantees that anybody can use RTP-MIDI without needing to pay any license and ensures that no company can claim RTP-MIDI to be its proprietary product. It is based on the well-known RTP protocol (listed as RFC3550 standard), which is based in turn on standard IP stack. This allows any RTP-MIDI product to use standard networks components.

RTP-MIDI does not necessarily relies on Ethernet and can be used over wireless links. However, the use of Ethernet guarantees extremely low latency over the complete network.

RTP-MIDI benefits from all RTP advantages, like clock synchronization, detection of loss packets, etc... Moreover, RTP-MIDI provides a recovery mechanism, which allows a receiver to detect missing informations due to lost packets. This innovating mechanism allows to recover MIDI data without needing any retransmission.

RTP-MIDI is natively integrated in iOS and Mac OS since 2006 (no need to install any driver on this platform), and free Windows drivers are now available for all Windows platforms from XP to Seven, in 32 and 64 bits versions.

3 - USING iPCM4

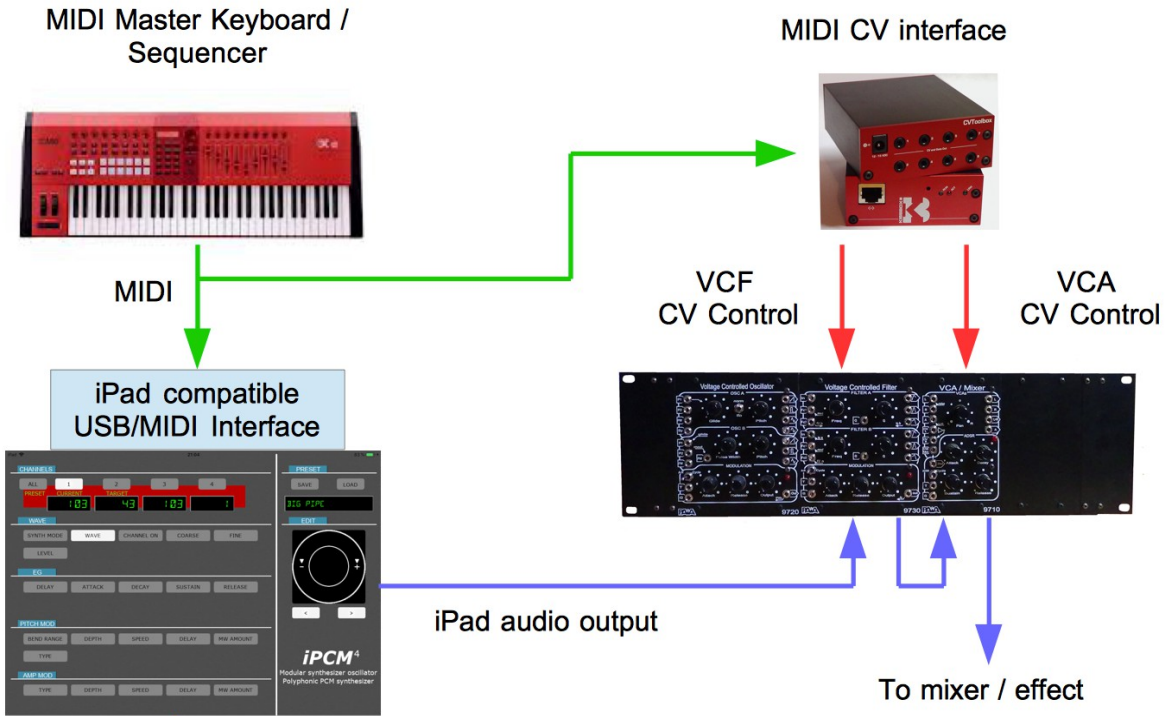
3.1 - System integration

3.1.1 - Integration in modular synthesizer setup

iPCM4 is the first iOS application written specifically to be used within a modular synthesizer setup, in which it will act as an powerful and flexible oscillator. It can be used in place of any oscillator module while providing rock stable stability thanks to its digital nature.

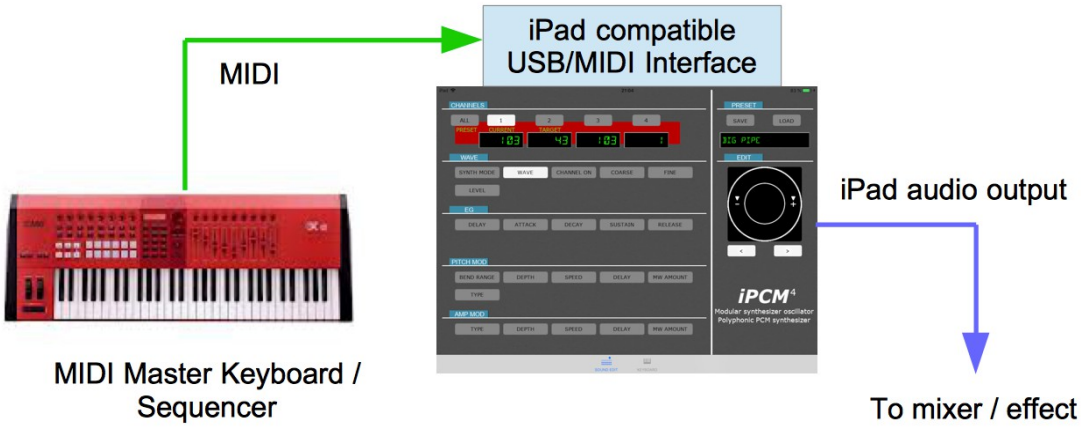
When used as a monophonic oscillator, iPCM4 outclasses most oscillators since it uses four parallel oscillators, with adjustable detune for each of them. And each oscillator provides 204 different waveforms, from very standard (square, sawtooth, sinus, etc...) to very unique ones.

But iPCM4 can also act as a paraphonic oscillator : it will then bring chord capabilities to your modular synthesizer even if your setup contains only one VCF and one VCA. The only needed extra module is a MIDI interface to drive your analog gear along with iPCM4.



3.1.2 - Standalone synthesizer

Even if it has been created to be used with modular synthesizers in mind, iPCM4 can perfectly work also without any external module. In fact, it is also a true standalone synthesizer which can be used in any studio. In this configuration, iPCM4 only requires an external keyboard, like all the other iOS synthesizers already available on AppStore.

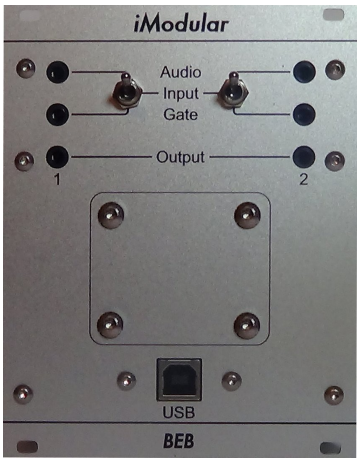


3.2 - Audio interface

The iPCM4 application uses the iPad audio system to provide audio signals to a modular synthesizer. Audio signals can be retrieved directly from the headphones jack located on iPad top side. However, it must be noted that the maximum signal level available on the headphone output is seen as quite low in comparison to what most synthesizer modules expect from oscillator modules. Moreover, headphone output can be quite noisy depending on the iPad model.

It is then better to use an external audio interface to get the best possible audio quality. Many audio decks designed for the iPad provide excellent audio signal quality.

If you plan to use the iPCM4 application as an oscillator for a modular synthesizer, we recommend to use the iModular audio interface designed by BEB. The iModular audio interface connects itself on USB and provides DC-coupled, high amplitude audio signal (up to 10V). The iModular audio interface can share the USB connection of the iPad with a MIDI interface. Please refer to MIDI interface chapter for details and recommendations.MIDI interface



3.3 - MIDI interface

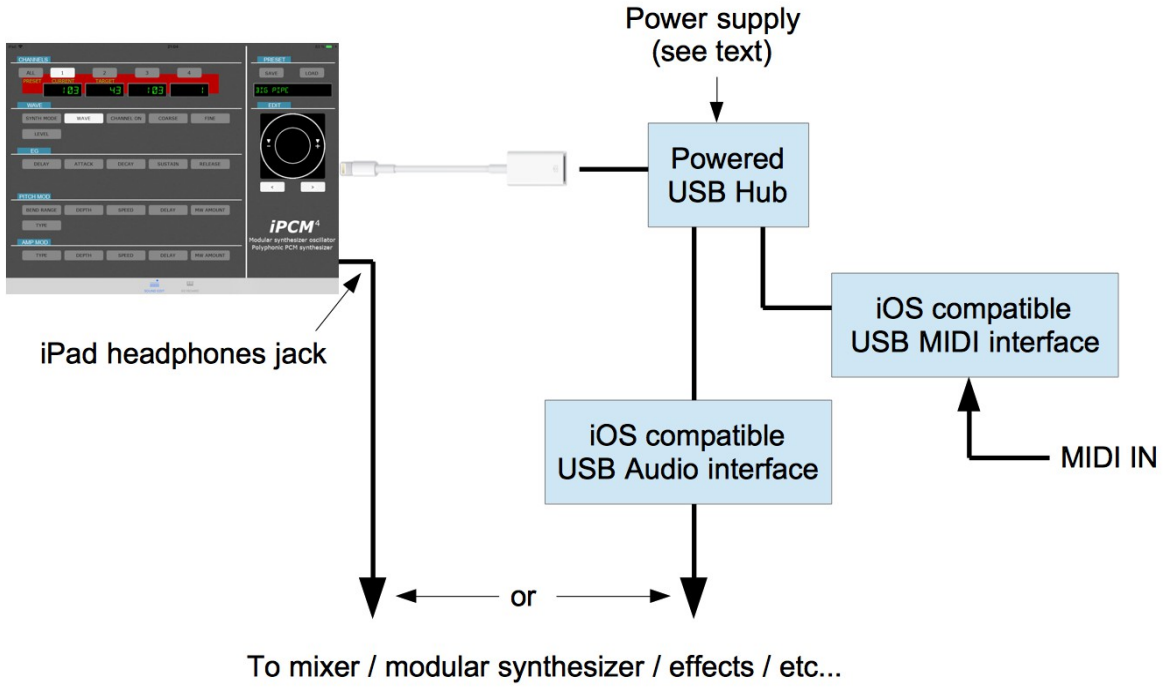
The iPCM4 application includes a small keyboard allowing to play directly from the application. However, it is highly recommended to control the application from a MIDI interface, so you can control it from any MIDI keyboard or sequencer.

The iPad is compatible with any MIDI 1.0 class compliant USB interface. To know if your MIDI device is class compliant, just connect it to a PC or Mac computer. If the interface is recognized immediately and does not request you to install a driver, then it is class compliant and will be recognized by the iPad. If your interface requires a driver to be installed, the iPad can not use it.

You will need a Apple USB adapter (known with older iPads as Camera Connection Kit) connected to the Lightning connector.

The MIDI interface can be connected directly to the USB adapter, which will provide power supply. Note however that iPad is not able to provide a lot of current to the MIDI device. Moreover, the current consumed by the MIDI interface is drawn from the iPad battery, which will reduce the autonomy accordingly. If your MIDI device consumes too much current, the iPad will switch its USB interface off and will not recognize the MIDI device.

We highly recommended to use a powered USB hub to connect your MIDI device. This device does not draw any current from the iPad and powers all MIDI devices connected to it. Almost all USB hub are recognized directly by the iPad, but in doubt, ask your reseller for a model which is known to work with iOS.



The USB hub will also be required if you use the BEB iModular interface. In that case, the hub will be used to

share the USB connector from the iPad between the MIDI and audio interface.

If you use a iPad docking station with audio and MIDI interfaces, you don't need any external USB hub, since the USB is directly integrated in the docking station.

3.4 - RTP-MIDI connectivity

All iOS products support natively RTP-MIDI protocol. The iPCM4 application can activate the iPad RTP-MIDI interface when it starts (see application settings chapter), so it can be driven in parallel from MIDI device on USB and RTP-MIDI on WiFi.

iPCM4 acts as a RTP-MIDI session listener, so you must have a RTP-MIDI session initiator device on the other side to open the RTP-MIDI session. The session initiator can be a physical device or a computer running RTP-MIDI driver :

- Mac OS computer (sessions are controlled by the MIDI Network applet in MIDI/Audio configuration)
- Windows computer running rtpMIDI driver provided by KissBox or Tobias Erichsen
- KissBox MIDI2TR
- KissBox CM-MIDI2
- KissBox RTP-MIDI OEM
- etc...

It must be noted that communication latency over WiFi can be quite high (up to 100 milliseconds) and extremely variable especially in busy WiFi environments. It is then not recommended to play notes on iPCM4 over the WiFi RTP-MIDI connection. However, RTP-MIDI connection can perfectly be used to control program changes for example.

4 - OPERATING MODES

The iPCM4 can operate under different modes, each mode providing dedicated sound capabilities and characteristics. Each iPCM4 preset can define the mode it uses, thus loading a preset will activate automatically the selected mode. You can then easily switch between the various modes by sending MIDI Program Change or by loading manually a new preset.

4.1 - Crossfade option

Most iPCM4 modes exist in two version :

- with crossfade
- without crossfade

To understand what crossfade option is, it must be understood how iPCM4 oscillators are working.

When a preset is loaded, each iPCM4 oscillator is associated with a waveform, each waveform being precomputed using harmonic synthesis. To avoid spectrum aliasing over the sampling frequency, the number of harmonics is reduced octave by octave (in other terms, the higher the octave, the less harmonics in each waveform).

On the iPCM4, the octave limit has been set on the C key. C0 to B0 key range is associated to a given number of harmonics within the waveform, C1 to B1 key range provides a waveform with a little less harmonics, etc...

The consequence is that the sound spectrum changes slightly between two consecutive keys if you pass the boundary between two octaves (between C and B keys on the iPCM4). This sound characteristic is very common on vintage synthesizers like the Korg DW6000, Korg DW8000, Korg DSS-1, Kawai K-1, Kawai K-3, etc...

The iPCM4 implements an optional algorithm, called "crossfade algorithm" which avoids this "brutal" spectrum change. When the crossfade algorithm is activated, each key will be associated with a mix between two harmonic contents : the harmonic content related to the current octave and the harmonic content of the next octave. The ratio between the two harmonic contents for each key is defined by the position of the key :

- the C key contains 100% of base harmonic content and 0% of the next octave harmonic content
- the C# key contains 92% of base harmonic content and 8% of the next octave harmonic content
- the D key contains 83% of base harmonic content and 17% of the next octave harmonic content
- etc...

The crossfade algorithm avoids the audible harmonic content change when you pass from B to C (or C to B) keys, providing then a smooth transition between all keys all over the keyboard range. This algorithm makes the iPCM4 sound like any modern PCM based synthesizer.

However, it is very important to understand that crossfade option consumes twice the resources for each oscillator (since each oscillator must play two waveforms with different harmonics content and mix them dynamically). Consequently, using the crossfade option in a mode will divide by two the polyphony capabilities of the mode (maximum number of notes that can be played at the same time)

In conclusion, iPCM4 offers you the possibility to choose between two sound characteristics :

- without crossfade, the iPCM4 sounds like vintage machines with brutal harmonic change, but with twice the possible polyphony
- with crossfade, the iPCM4 reacts like modern sample players, with smooth transitions all over the keyboard range, but it divides by 2 the maximum number of notes that can be played at the same time.

4.2 - Monophonic oscillator modes

The monophonic oscillator modes are dedicated to modular synthesizer applications. In these modes, the iPCM4 acts as a parallel four-channel PCM oscillator.

When iPCM4 runs in monophonic oscillator modes, the Envelope Generators are deactivated. Thus, you must use external VCA and EG modules. However, the Pitch Modulation and Amplitude Modulation sections are active and can modulate any of the four oscillators.

There are two modes available when the iPCM4 is configured as monophonic oscillator:

- with crossfade
- without crossade

Note that polyphony restrictions described in previous section do not apply to monophonic oscillator modes. As the name says, only one note can be played at a time in these mode (like with any oscillator module for modular synthesizers). However, note that using the crossfade option will lead to higher CPU consumption (and thus slightly lower battery autonomy).

To select the monophonic oscillator mode, press the SYNTH MODE button :

Using the edition keys, select either "MONO DCO XFADE" or "MONO DCO" modes. Press again SYNTH MODE button to exist mode selection and allow sound edition.

4.3 - Polyphonic synthesizer / paraphonic oscillator modes

When you use the "Upload all programs to CV Toolbox" button, the whole bank from the plug-in is transferred to the CV Toolbox (32 programs), and all programs are automatically stored in the non-volatile memory

4.3.1 - PAR2 modes

PAR2 modes use two channels in parallel per voice. Each channel comprises an oscillator driven by its own envelope generator. Each oscillator has its own tuning parameters (coarse and fine tuning of each oscillator). Each oscillator can also be modulated in pitch and amplitude from two Low Frequency Oscillators (one for pitch modulation, one for the amplitude modulation)

The PAR2 modes can be used to generate sounds like the ones produced by most hybrid synthesizers manufactured in 80's, like the DW6000, DW8000, DSS-1, K-3, etc...

4.3.2 - PAR4 modes

PAR4 modes use four channels in parallel per voice. Each channel comprises an oscillator driven by its own envelope generator. Each oscillator has its own tuning parameters (coarse and fine tuning of each oscillator). Each oscillator can also be modulated in pitch and amplitude from two Low Frequency Oscillators (one for pitch modulation, one for the amplitude modulation).

The PAR4 modes can be used to generate sounds like the ones produced by the Kawai K-1 or the Kawai K-4 synthesizers.

The PAR4 modes can also be used to produce "wavetable-like" sounds. Each oscillator is driven by its own envelope generator, which has a delay parameter. The envelope of each oscillator can then be delayed, shifting in time appearance of its spectrum. It is then possible to produce any kind of spectrum variation, from subtle one to heavy spectrum changes.

5 - SOUND EDITION

iPCM4 sounds are created from multiple parameters. All the parameters (except the synthesis mode) are edited using the same method, which is described below. Sound edition is only possible when the iPCM4 is not in one of the following modes :

- Synthesis mode selection (se previous chapter)
- Save mode
- Load mode

You must exist these modes to edit sound parameters.

5.1 - Parameter selection

Parameters are organized in family to identify their function easily :

- Wave
- Envelope generator (EG)
- Pitch modulation
- Amplitude modulation

Selection of a parameter is done by pressing its button. The button then lights up to confirm the selection, while the value of the parameter for each channel are displayed on the channel displays.

Some parameters (like LFO frequency or LFO waveform) apply to all channels. In that case, the value is only displayed on the left most display.

5.2 - Channel selection

Many parameters can be applied with different values on the four possible channels of a voice (in other terms, each channel of a voice can be adjusted separately of the others. This offers almost unlimited sound creation capabilities).

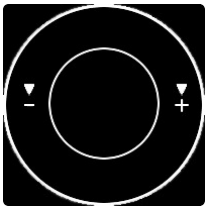
Selection of the channel to edit is done by pressing channel buttons 1 to 4. When a channel is selected, the edition is limited to this channel only, the other channels keeping their values for the matching parameter.

In some cases, it is easier to edit all channels at the same time. To activate all channels for edition, press the ALL button. The four channel buttons will then active. To return to single channel edition, press any channel button.

5.3 - Value edition

Once a parameter and one/all channel(s) have been selected, you can freely edit the parameter value. Edition is performed using the wheel and the arrow buttons.

The wheel allows fast changes of value. Place your finger on the circular track (where "-" and "+" signs are written) and move along the track in the desired direction. The wheel is mostly use for coarse value changes, followed by precise changes using the arrow buttons.



The arrow buttons allow precise value adjustments. The displayed value is incremented or decremented of only one point each time a button is depressed.

6 - PRESET MANAGEMENT

6.1 - Loading preset

The iPCM4 application can store up to 128 presets on the iPad. To load a previously saved preset into the Preset Edition Buffer, press on the LOAD button. The button will light to indicate that the load procedure is active:

The LOAD procedure can be cancelled at any time by pressing any channel selection button (ALL, 1, 2, 3,4). The LOAD button will then deactivate.

When the LOAD button is active, you can use the edition wheel and the arrow buttons to browse the iPad preset memory. The selected preset number is displayed on the TARGET display. If the selected preset exists in the iPad memory, its name is displayed on the preset display on the top right. If there is not yet a preset with corresponding number in the iPad memory, "NO PRESET" is displayed.

Once you have selected the preset you want to load, press the LOAD button to confirm. The preset file is then loaded in the local edition buffer and can be played.

If you try to load a preset which is not yet in the iPad memory, iPCM4 will display an error message.

6.2 - Saving preset

Parameters of the sound loaded in the iPCM4 memory are stored in a temporary area called the Preset Edition Buffer. The content of this buffer is lost when a new sound is loaded or when the application is closed.

The SAVE function allows you to store your created sounds in the non-volatile Flash memory of the iPad. Once saved in this memory, the sounds can be loaded and exchanged with other iPCM4 users.

To save a preset, press on the SAVE button. The button will light to indicate that the saving procedure is active :

The SAVE procedure can be cancelled at any time by pressing any channel selection button (ALL, 1, 2, 3,4). The SAVE button will then deactivate.

When the SAVE button is active, you can use the edition wheel and the arrow buttons to select in which preset memory the sound will be stored. The preset number in which the sound will be stored is displayed on the TARGET display. The CURRENT display shows the current preset number as a reminder.

Once you have selected the preset number in which you want to save your sound, press the SAVE button a second time. The preset file is then stored in the non-volatile memory.

6.3 - Managing / Adding custom presets to iPCM4

The iPCM4 application stores all presets in a specific file area that can be reached from outside the iPad. This allows to manage multiple preset banks using an external computer (you can swap presets between a computer and iPCM4 for example), but this means also that iPCM4 users can share their sounds. You can download a preset made by another user or from our website from the Internet and copy it within the iPCM4 memory.

6.3.1 - Using Files

iPCM4 presets are visible from iPad Files application, which can then be used to browse, manage and shares

all your presets.

WARNING : Files application can be removed from the iPad and is available only in recent iPads (minimum version to support Files is iOS 11). In case you don't see Files app, please check the two following points :

- Your iPad is recent enough to support Files (minimum version = iOS 11.0)
- Files application has not been removed by user. In that case, just connect to AppStore and re-install Files

To get access to iPCM4 presets from Files app :

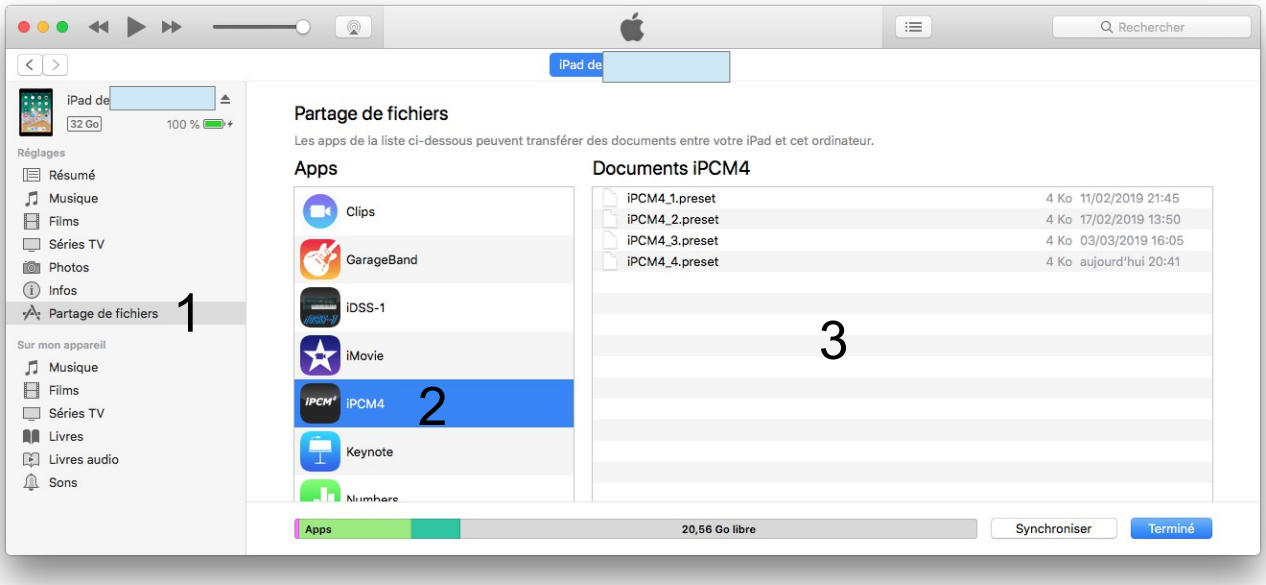
- Start Files by touching its icon

- Touch the "On my iPad" in the "Browser" section. You will then see the applications on your iPad which support file browsing.
- Touch iPCM4 line or icon (depending on the display mode) on the right side of the screen : all presets stored on your iPad are now visible
- Select one or more presets to get access to commands (Share, Copy, Move, Delete)

6.3.2 - Using iTunes

iPCM4 presets can also be accessed using iTunes, in case you run the application on an older iPad which does not support Files based document sharing.

- Connect the iPad with iPCM4 application to a PC or a Mac with the iTunes application installed
- Start iTunes
- Click on the iPad in the list of devices (top left area of iTunes main window), this will open the overview window
- In this view, click the "File sharing" button (1)
- Click on "iPCM4" in the "Apps" list (2)
- All presets created by the local iPCM4 are available in the Documents panel (3)



The files can be exchanged between iPCM4 application and the computer with iTunes simply by drag&drop operation. It is then possible to backup your presets on the computer and replace the presets in the iPad memory with presets coming from another source.

Preset number is stored in the file name, to allow easier bank management (file names are from iPCM4_1.preset to iPCM4_128.preset for presets 1 to 128). You can edit the file name by yourself and change the preset number as needed, as long as the file name format structure is kept (iPCM4_xxx.preset, with xxx being the preset number)

7 - APPLICATION SETTINGS

As many other iOS applications, iPCM4 has settings that can be adjusted to adapt precisely to your needs and various iPad models. To access the settings, you must exit iPCM4, then touch the Settings icon on first page.

Once the Settings page is opened, scroll the application list on the left down until you see the iPCM4 icon in the list. Touch the line to display the application settings.

7.1 - RTP-MIDI option

The "Activate RTP-MIDI by WiFi" option allows to enable or disable the RTP-MIDI communication function within iPCM4.

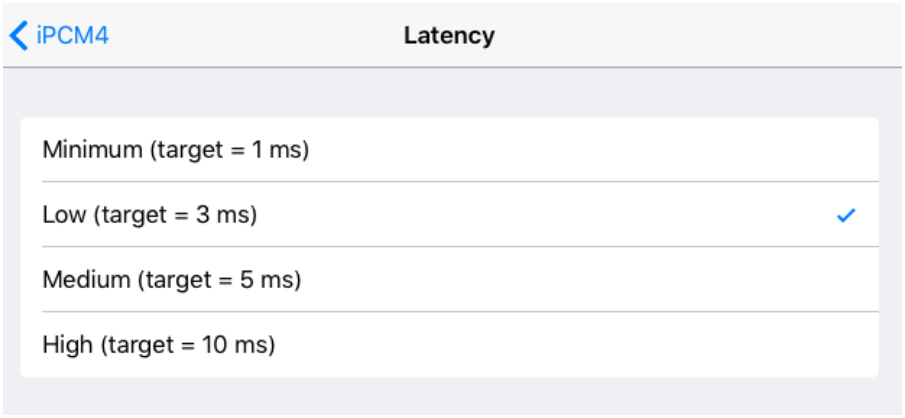
If the option is active, iPCM4 will react to MIDI messages received on RTP-MIDI link. Otherwise, iPCM4 will only take into account MIDI messages from the USB interface.

Note that this button does not control the RTP-MIDI client within the iPad, it just allows or not the application to accept the MIDI message from RTP-MIDI. The RTP-MIDI client can then still be invited by a session initiator and accept the session even if this setting is set to OFF.

7.2 - Latency setting

This setting defines the audio latency for iPCM4. The latency should always be as low as possible, but the minimum latency you can achieve on a given iPad depends directly on its model (more precisely, the CPU model inside the iPad)

There are four possible latency settings in iPCM4 :



The minimum latency is only possible on latest iPad models. It makes the iPCM4 extremely responsive (better than what you can achieve on many computers...) but it requires more CPU processing power.

The "high" settings make iPCM4 with absolutely all iPad models, but the latency may be disturbing for many musicians.

The best way to adapt the latency is to set it to the minimum. Try then playing a complex sequence on the iPCM4 application. If you hear undesired noise (crack, pops...) or if there are drops on the audio output, set the latency to the next value until the audio output is not disturbed anymore.

Note that most iPad work perfectly with settings set to "Medium" or "Low"

8 - WAVEFORM DIRECTORY

All iPCM4 have been created using harmonic synthesis, either from analysis of acoustic instruments or from mathematical analysis (especially for square and sawtooth waves). The following table is provided as an guideline, as an acoustic instrument sound is defined both by its spectrum, but also by the sound envelope. For example, a "piano" waveform can sound totally different (maybe like an organ) if you use an envelope which is different from the piano one.

Most waveforms have been computed to avoid aliasing, but some waveforms have been deliberately computed to include aliasing noise. These waveforms can be used to generate sounds with similar characteristics of very first digital oscillators used in synthesizers in the 80's.

Number	Wave	Aliased	Number	Wave	Aliased	Number	Wave	Aliased
1	Sinus (1f)		2	Sinus (2f)		3	Sinus (3f)	
4	Sinus (4f)		5	Sinus (5f)		6	Sinus (6f)	
7	Sinus (7f)		8	Sinus (8f)		9	Sinus (10f)	
10	Sinus (10f)		11	Sinus (11f)		12	Sinus (12f)	
13	Sinus (16f)		14	Saw 1		15	Saw 2	
16	Saw 3		17	Saw 4		18	Saw 5	
19	Saw 6		20	Saw 7		21	Saw 8	
22	Saw 9		23	Saw 10		24	Saw 11	
25	Saw 12		26	Saw 13		27	Saw 14	
28	Saw 15		29	Saw 16		30	Saw 17	X
31	Saw 18	X	32	Saw 19	X	33	Square 1	
34	Square 2		35	Square 3		36	Square 4	
37	Square 5	X	38	Inv. Saw		39	Triangle	
40	Noise		41	French Horn		42	String 1	
43	String 2		44	String Pad		45	Piano	
46	El. Grand		47	E. Piano 1		48	E. Piano 2	
49	E. Piano 3		50	Clavi		51	Vibe	
52	A. Guitar		53	F. Guitar		54	F. Guitar 2	
55	Ac. Bass		56	Ac. Bass 2		57	Digi Bass 1	
58	Pick Bass		59	Digi Bass 2		60	Round Bass	
61	Fretless 1		62	Fretless 2		63	Flute	
64	Pan Flute		65	Harmonica		66	Glockenspiel	
67	Tine		68	Harp		69	Marimba	
70	E. Tom		71	Log Drum		72	Jazz Organ 1	
73	Mellow Pad		74	Synth Solo		75	Synth 2	
76	French Horn		77	French Horn 2		78	Brass 1	
79	Brass 2		80	Brass 3		81	Brass 4	
82	Trumpet 1		83	Trumpet 2		84	Violin	
85	String		86	Piano 1		87	Piano 2	
88	Piano 3		89	Piano 4		90	Piano 5	

Number	Wave	Aliased	Number	Wave	Aliased	Number	Wave	Aliased
91	Piano 6		92	Piano 7		93	El. Grand 2	
94	E. Piano 4		95	E. Piano 5		96	E. Piano 6	
97	Clavi 2		98	Harpsichord		99	Vibe 2	
100	A. Guitar 2		101	F. Guitar 2		102	Strato	
103	Strato 2		104	Ac. Bass 3		105	Pull Bass	
106	Pull Bass 2		107	Round Bass 2		108	Slap Bass	
109	Slap Bass 2		110	Slap Bass 3		111	Fretless 3	
112	Fretless 4		113	Synth Bass 1		114	Synth Bass 2	
115	Harmonica 2		116	Clarinet		117	Clarinet 2	
118	Oboe 1		119	Oboe 2		120	Shakuhachi	
121	Oriental Bell		122	Oriental Bell 2		123	Bell	
124	Koto		125	Sitar		126	E. Tom	
127	Log Drum 2		128	Log Drum 3		129	Steel Drum	
130	Steel Drum 2		131	Voice 1		132	Voice 2	
133	Accordion		134	Accordion 2		135	Jazz Organ 2	
136	Rock Organ 1		137	Draw Bar 1		138	Draw Bar 2	
139	Pipe Organ 1		140	Pipe Organ 2		141	Rock Organ 2	
142	Synth Solo 2		143	Synth Solo 3		144	Synth 3	
145	Synth 4		146	Synth 5		147	Brass 5	
148	Brass 6		149	Orchestra		150	Piano 8	
151	Piano 9		152	E. Piano 7		153	E. Piano 8	
154	E. Piano 9		155	E. Piano 10		156	Clavi 2	
157	Harpsichord 2	X	158	Harpsichord 3		159	Vibe 2	
160	Digi. Bass 3		161	Digi. Bass 4		162	Digi. Bass 5	
163	Pick Bass		164	Glockenspiel 2		165	Glockenspiel 3	
166	Tine 2		167	Tine 3		168	Tine 4	
169	Tube Bell		170	Tube Bell 2		171	Tube Bell 3	
172	Xylophone		173	Xylophone 2		174	Harp	
175	Koto 2		176	Sitar		177	Sitar 2	
178	Kalimba		179	Kalimba 2		180	Kalimba 3	
181	Log Drum 2		182	Steel Drum 2		183	Pipe Organ 3	
184	Pipe Organ 4		185	Synth 6		186	Synth 7	
187	Synth 8		188	Synth 9		189	Synth 10	
190	Synth 11		191	Clavi 3	X	192	Digi. Bass 6	
193	Dgi. Bass 7	X	194	Pick Bass 2		195	Pick Bass 3	
196	Round Bass 2		197	Round Bass 3		198	Harmonica 2	
199	Harmonica 3		200	Harp 2		201	Koto 3	
202	Sitar 3		203	Marimba 2		204	Synth 12	